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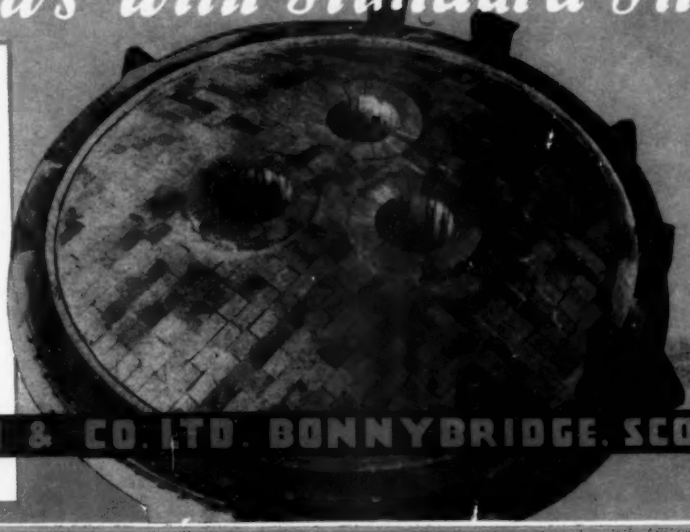

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FOUNDRY TRADE JOURNAL
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Vol. 70 Thursday, August 12, 1943 No. 1408

Extinguishing Magnesium Fires

Most of our home readers have more than an academic interest in fires resulting from the ignition of magnesium, whilst those actually engaged in the production of castings from this metal have an added responsibility. Mr. H. A. Knight has contributed to "Metals and Alloys" an article which deals at length with all the confusing notions on the subject which have been more or less authoritatively advanced on both sides of the Atlantic. Primarily, there must be a differentiation between magnesium and its alloys and thermit—not thermite as the A.R.P. authorities will insist on calling it. The latter is a mixture of iron oxide and magnesium, and when once ignited provides enough heat to produce liquid iron or steel (if carbon be present), and the system was in use for many years for the welding of the ends of tramway rails. When used as the filling of incendiary bombs, it is obviously more than sufficient to melt the magnesium alloy shell. Thus when tackling a bomb, it can reasonably be expected that after a period of seven minutes the material can be considered as magnesium, and if there be good methods for extinguishing it other than by water, which, after all, can do no more than wet the immediate surroundings and so prevent the fire from spreading, then they should be examined. The American Bureau of Mines recommends for the extinguishing of magnesium the application of granulated hard coal-tar pitch. This melts and forms a blanket of sufficient thickness to exclude the entry of oxygen, and so inhibit further combustion. Naturally it creates an objectionable black smoke instead of the white magnesium oxide fume. In America people are generally satisfied with this ameliorative, providing the weight of magnesium does not exceed 6 to 10 lbs., after which it merely adds fuel to fire, and as incendiary bombs usually weigh less than this figure, the method seems attractive. For works use, Mr. R. I. Thune, the safety engineer for the Dowmetal Division of the Dow Chemical Company, where larger fires may be involved, recommends a proprietary article called G.I. powder, made by the Pyrene Manufacturing Company of Newark, New Jersey. This powder, which is made up of graphite, together with a liquid plasticiser, is often used with dry clean cast-iron borings and more powdered graphite. For quite small fires which may take place on or near the machine tools, the use of unoxidised cast-iron borings is often effective, especially near grinding machines. If a fire starts in a heat-treating furnace, all circulating fans and heating elements should be immediately and preferentially automatically shut off, and where the chamber is small, it is recommended that a large quantity of waste soaked in oil should be thrown in and the doors then tightly sealed. Where large components are being treated then the American practice is to pump in this G.I. [G-one] mixture. Mr. Knight gives some notes as to the types of floors for carrying out experiments with extinguishers. Cement floors are ruled out, as the combined water, let alone normal dampness, causes mild explosions. If the floor is inflammable, then the magnesium should be hoed—a better word than raked—on to a layer of extinguishers and a sandwich made by the addition. Thus a steel plate or good hard wood is satisfactory. It appears that wood can be quite useful even against incendiary bombs, as the layer of charcoal formed is more resistant to the liquid magnesium than a steel plate. A final recommendation is that all machine tools handling magnesium should be properly earthed in order to cut down hazards arising from the incidence of static electricity. Sand, although used by the Ford Motor Company of Detroit, does not find favour, as there

(*Continued overleaf.*)

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FUTURE OF THE ELECTRICAL INDUSTRY

The part which the company must be prepared to play in the post-war world was discussed by Mr. A. H. Railing (chairman) at the annual meeting of the General Electric Company, Limited, last week. He said that they were naturally trying to plan for the time when the present catastrophe would have found its ultimate inevitable solution so that they might play the part which they owed to the nation and to themselves both during the reconstruction period and afterwards according to the conditions which might apply. Some of these conditions could not yet be clearly foreseen as, for instance, the degree of international co-operation for the marketing and exchange of goods, the relative importance of replacing capital goods or providing consumers goods immediately after the war, the spending power available for various countries, and the measure of expansion allowed to various industries. It was self-evident that some clarification on these points would have to take place before definite decisions could be made. Yet one factor stood out clearly. Given a degree of security to plan for a period of years, there were unlimited possibilities in their industry to expand and provide employment both in the fields of application which they had successfully covered in the past, as well as in new fields hardly yet dreamt of, which could be uncovered by far-sighted research. The company had always realised the fundamental importance of research for industry, and the vigorous research policy which they had followed for many years had fully justified itself in peace and war. They were more than ever determined to continue it and to expand it further.

A long-term policy was the first essential for these plans, said Mr. Railing. The Prime Minister pleaded in another sphere for a four years' plan. They, as well, must be able to organise not on the basis of a yearly budget but for a much longer period.

CUMBERLAND IRON ORE MINERS

At a mass meeting of iron-ore miners, held in Egremont, Cumberland, the organiser reported on the negotiations which had taken place at a meeting of the Iron Ore Conciliation Board.

He stated that the claim for additional holiday pay was met by an offer by the owners of adding the cost-of-living bonus to the amount already paid. This at present stands at 11s. 4d. On the men's claim for extra payment for wet workings, the owners said it had never been the practice to pay extra for wet workings in the industry, and they were not prepared to do so now. The organiser, on behalf of the workers, said that the workers would take individual action on each case as it arose.

The question of additional overtime payments was referred to arbitration.

On the question of non-unionism, the organiser reported that 100 per cent. membership had been accomplished at four mines and nearly reached at two others.

A CORE-MAKING EXPERIMENT

By G.W.L. (Coventry)

The following core-making experiment is recommended when "large" cores are required; it was suggested by the gravity die-casting practice of core application in the semi-permanent mould. It is the tendency of design in such examples to match the sand part of the mould with the metal die mould so that a more even casting surface is maintained. In these circumstances a non-porous refractory wash is applied to the oven-dried cores for the purpose.

For wider and more general application it is useful to provide the conditions described below and as given in Fig. 1. Use a wash similar to that employed in die-casting, *id est*, 1½ ozs. of sodium silicate, 3 ozs. of whiting, chalk or fireclay, ½ to 1 oz. of plumbago

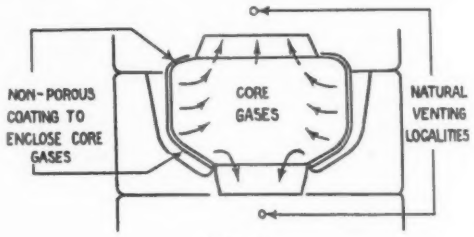

FIG. 1.

(if permissible), and 2 pints of water, and apply to the mould form of the core before drying. During drying the heat is relied upon to create the nature of partial vitrification to the outside of the core and thereby producing a more durable surface. In casting this added surface is to enclose the internal core gases so that they will disperse through the open print locations as shown in Fig. 1. By this method the core gases do not enter the mould cavity and they find the natural venting localities and the risers also give better results with the slightly less outlet of gases. Although primarily intended for non-ferrous foundry work its application is not limited and it may be extended to skin dried cores.

EXTINGUISHING MAGNESIUM FIRES

(*Concluded from previous page.*)

is said to be a reaction between burning magnesium and silicate, producing no doubt a magnesium silicate. From this and the author's general conclusions, there is, as yet, no full agreement in the States as to the best method of tackling this class of fire, but stress is laid upon prevention by adequate dust collection methods and the availability of extinguishing apparatus.

MEETING THE RAW MATERIALS SUPPLY POSITION IN GREY IRON FOUNDRIES

A REPORT BY THE CAST IRON SUB-COMMITTEE OF THE TECHNICAL COMMITTEE OF THE INSTITUTE OF BRITISH FOUNDRYMEN

Report submitted at the Fortieth Annual Conference of the Institute of British Foundrymen

Constitution

The constitution of the Cast Iron Sub-Committee of the Technical Committee is as follows:—

P. A. Russell, B.Sc. (Convener), Dr. A. B. Everest (Secretary), S. Carter, E. B. Ellis, H. Forrest, G. L. Harbach, Dr. J. E. Hurst, A. Phillips, R. C. Tucker, M.A., T. R. Twigger, and H. J. V. Williams.

Introduction

In any casting the primary requirement is soundness and freedom from internal defects. This consideration stands in front of all other qualities, such as mechanical strength. One of the most significant elements in cast iron from the point of view of its influence on soundness is phosphorus; but to-day foundrymen are being asked to use increasing amounts of native high-phosphorus irons and to conserve low-phosphorus materials such as hematite, steel scrap, and refined iron. Whilst these materials have been available for all essential demands, the iron foundries, as a whole, have had to cut down consumption for all purposes where it cannot be proved that their use could not be reduced or eliminated. Phosphorus has also a marked influence on the mechanical properties of cast iron, generally lowering strength, and particularly in reducing impact resistance or toughness. The use of phosphoric pig or scrap tends, therefore, to increase the difficulties of the foundryman in meeting specifications. This Report has been drawn up in an attempt to assist foundrymen in maintaining quality of output while meeting the supply position by using lower-grade raw materials.

Apart from meeting the high mechanical strength specifications, low-phosphorus irons find a use as a means for ensuring soundness, particularly in castings which are subjected to pressure tests after machining. There are castings in which the mechanical strength requirements are low enough to permit of the use of native phosphoric irons, but for which low-phosphorus irons are used frequently in order that their freedom from porosity can be ensured.

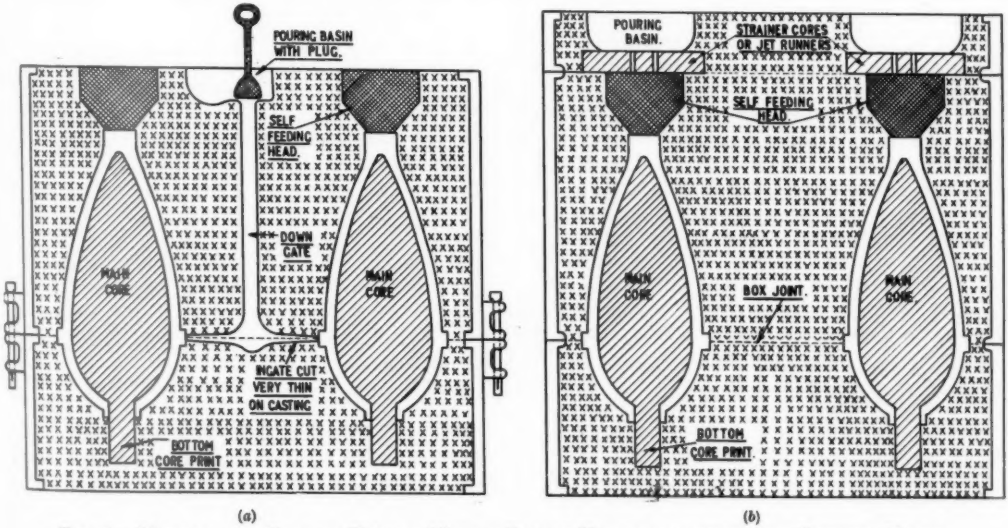

FIG. 1.—METHODS OF CASTING TRENCH MORTAR BOMBS VERTICALLY WITH SELF-FEEDING HEADS.
(*a*) In 2-part moulding boxes with runner on joint. (*b*) With strainer or jet runners on top.

Supplies for Grey Iron Foundries

Up to the present there is little evidence that the resulting products have suffered from curtailment of supplies, and foundries have, as a whole, adjusted themselves very satisfactorily to the altered conditions. Difficulties must have been encountered, and, in view of this, and the fact that more severe curtailment in supplies of hematite and steel scrap may have to be faced in future, the Sub-Committee feel that its members' experience may be of value to members of the Institute in general, who may be faced with problems similar to their own.

The Report is based on experiences to date in

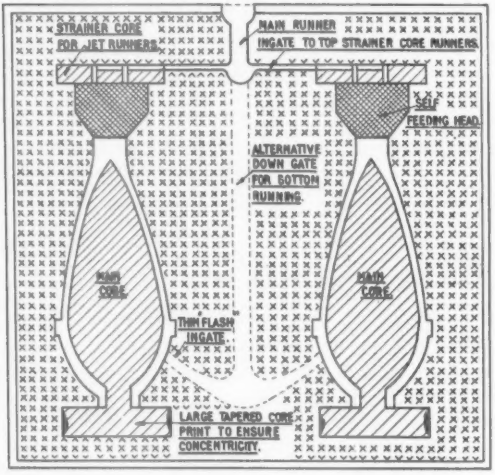
STRAINER CORE FOR JET RUNNERS
MAIN RUNNER
INGATE TO TOP STRAINER CORE RUNNERS
SELF FEEDING HEAD
ALTERNATIVE DOWN GATE FOR BOTTOM RUNNING
MAIN CORE
MAIN CORE
THIN FLASH INGATE
LARGE TAPERED CORE PRINT TO ENSURE CONCENTRICITY.

FIG. 2.—DIAGRAMMATIC SKETCH OF "DRAG" HALF OF MOULD SHOWING CORE IN POSITION, ALSO SUGGESTIONS FOR TOP AND BOTTOM RUNNING WITH FEEDER HEAD. MOULD IS PRODUCED FROM SPLIT PATTERN AND TURNED ON END TO CAST.

meeting the changed raw materials supply position, and includes a number of examples taken from practice. It concludes with suggestions for meeting conditions of further stringency in supplies.

Meeting the Position

The restrictions in low-phosphorus materials have largely been met by:

(*a*) Substitution of hematite by low-phosphorus blast-furnace pig-iron with P about 0.4 per cent., resulting in general increase in phosphorus. If the proportion of hematite in the charge did not exceed 30 per cent., the resulting increase in P was only 0.1 per cent., and this rarely caused any difficulty.

(*b*) Replacement of hematite by refined pig-iron. Low-phosphorus refined pig-iron is obtainable at a premium, and it has been possible to maintain castings at the same phosphorus level as before, while at the same time dispensing with the use of a certain amount of steel scrap. The use of very low-phosphorus refined pig-iron is discouraged, and a slight increase in phosphorus, as indicated in (*a*) above, can usually be tolerated.

(*c*) By careful control over the metal mixture, and especially over carbon and silicon contents whereby the deleterious effects of phosphorus on mechanical properties may be eliminated or counterbalanced. The use of late silicon additions is strongly recommended.

(*d*) By giving careful attention to improved methods of running and rising, *e.g.*, by the increased use of feeding heads, by the adoption of new running methods incorporating "atmospheric feeding" and special types of feeder gates.

(*e*) By adopting centrifugal casting methods wherever practicable.

(*f*) By careful attention to pouring temperature.

(*g*) By the correct use of denseners.

In elaboration of these points the following details and examples supplied by members of the Sub-Committee may be of interest.

Example I.—Trench Mortar Bombs in Phosphoric Cast Iron

Several methods have been used quite successfully for the production of T.M. bomb body castings in green sand moulds without the use of feeding heads. According to the type of tackle available, these may be cast either vertically with the tail up, vertically with the nose up, or on the flat. In nearly every case,

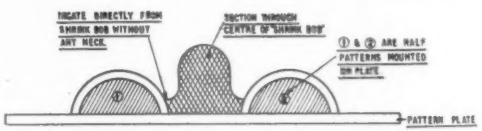
INGATE DIRECTLY FROM SHRINK BOB WITHOUT ANY NECK.
SECTION THROUGH CENTRE OF SHRINK BOB
① & ② ARE HALF PATTERNS MOUNTED ON PLATE
PATTERN PLATE

FIG. 3.—SECTION THROUGH TWO HALF PATTERNS SHOWING TYPICAL "SHRINK BOB" OR "BLIND FEEDER." BOMB BODIES CAST ON FLAT AND MAIN GATE INSERTED BETWEEN THE SHRINK BOBS FOR EACH 4 CASTINGS IN 2 PAIRS.

however, this entails the use of cast iron with comparatively low phosphorus content, certainly not over 0.5 per cent.

In order not to exceed this maximum phosphorus content, it is necessary to include a considerable proportion of hematite, refined iron, steel scrap or similar low-phosphorus materials in the mixture. Since only very moderate physical properties are required in this type of casting, methods have been successfully devised to make use of phosphoric iron with a final phosphorus content of 0.9 to 1.2 per cent.

In order to achieve complete pressure tightness with this type of high-phosphorus composition, the most reliable method is to cast the bomb bodies

vertically, with the tail uppermost and with the addition of a suitably designed feeding head on the top of the casting. This feeding head need not be of large proportions, provided it is so designed that it is the last portion of the casting to solidify and thus provides a suitable reservoir of liquid metal to feed the casting proper. The accompanying sketch (Figs. 1A and 1B) gives details of the design of feeding head most usually adopted.

It is assumed that the moulds will be produced in green sand on moulding machines or by plate moulding. The exact method will depend on the type of tackle available. If it is desired to mould the castings vertically, then the joint will be at the middle of the band in a simple two-part mould. When this method is adopted, it will, of course, be necessary to use loose feeding head patterns in the cope portion of the mould. These will be withdrawn from the top side, leaving open feeding heads. The runner will be located on the joint of the mould, and the actual ingate must be kept as small as possible, in order to prevent any risk of "drawing" from the thicker portion of the gate. This latter tendency can be obviated by the application of jet type runners placed directly over the feeding head, but of course this involves the use of an additional top part to carry the jet runners.

When commencing production for the first time in any foundry it would be much more economical to use half patterns mounted on plates complete with feeding heads and runners. The moulds are then made on moulding machines or by plate moulding on the flat, in simple two-part boxes adapted for vertical casting. In order to avoid the risk of swollen castings or "burst outs," it is a very simple matter to apply loose clamping plates when the boxes are ended for casting. Fig. 2 illustrates this second method.

Where it is absolutely impossible to use feeding heads or cast the bomb bodies vertically, it may be just possible to cast them on the flat in phosphoric cast iron, by making use of the well-known practice adopted by malleable iron foundries by the provision of runners combined with "blind risers" or "shrink bobs" (see Fig. 3).

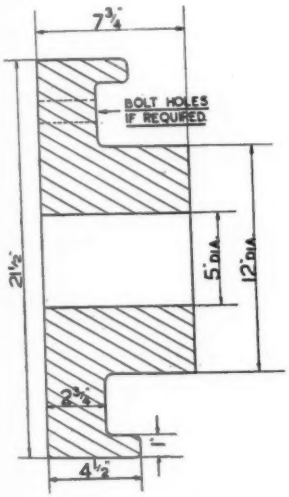

FIG. 4.—SECTION OF TYPICAL COUPLING WITH DIMENSIONS.

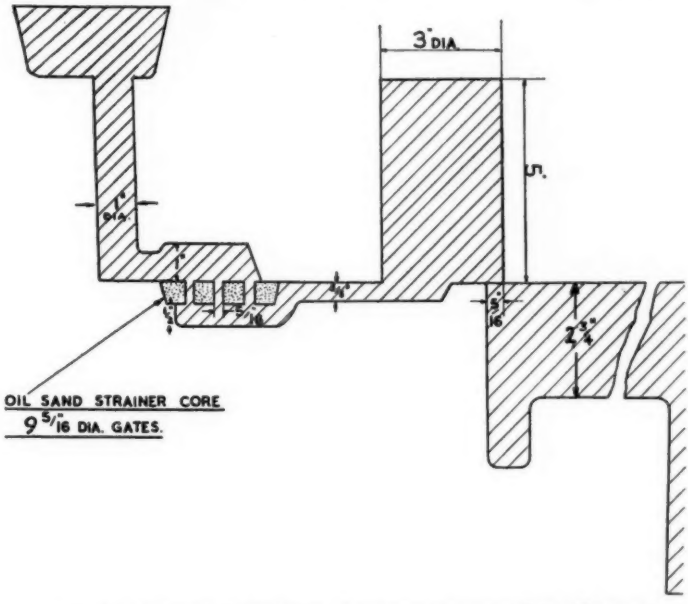

FIG. 5.—METHOD OF RUNNING COUPLING SHOWING CROSS-SECTION THROUGH RUNNER/RISER AND PART SECTION OF THE COUPLING CASTING.

Example II.—Coupling Castings

Certain coupling castings present special difficulty in the foundry and have, therefore, been made in low-phosphorus, low-carbon irons, in the main because

this type of casting (Fig. 4) is essentially a compact mass of metal which must not only be machined on all its faces, but which is subject in most cases to operations which will reveal any suggestions of porosity in its interior structure. This example shows how one foundry, by careful attention to method, has been able to raise the phosphorus content of the mixture employed for these castings. The foundry from which this example is taken has a very large proportion of its output in castings of this type, and until comparatively recently the iron used was of the order T.C 3.0 per cent., P 0.25 per cent. max., with silicon variations according to size and section. The castings vary in weight from 14 lbs. to 15 cwts., the majority falling between 100 and 750 lbs.

Experiments were conducted to ascertain the possibility of using a higher phosphoric iron with, incidentally, a higher carbon content. These experiments were successful, the final analysis for one size of casting being T.C 3.28, Si 1.27, Mn 0.58, P 0.63 and S 0.14 per cent., with a tensile strength of 16 tons on the 1.2-in. bar. Equally successful results were obtained on other sizes of castings, modifying the silicon content as necessary.

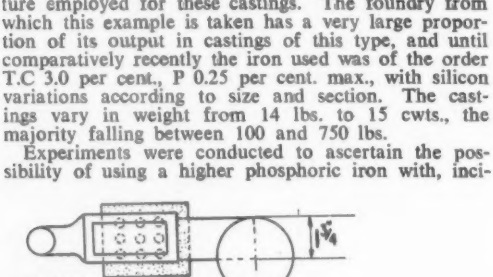

FIG. 6.—PLAN SHOWING RUNNER AS IN FIG. 5.

The successful adoption of the higher phosphorus iron depends on the running technique employed, as illustrated in Figs. 5 and 6. Rod feeding is never used, except with unusually long bosses, and then only in conjunction with the self-feeder on the rim. It is of interest to note that in the majority of cases the bolt holes are bored out of the solid and very rarely do these show any signs of porosity.

The method of production necessitates the use of hot metal and relatively slow pouring, and thus the moulds have to be strongly constructed, particularly the top part. It will be observed that in this case it has been possible to use an iron with 0.3 per cent. P above normal practice, thus reducing the steel consumption without prejudicial effect on the castings produced.

Example III.—Centrifugal Casting

Centrifugal casting, where it can be applied, provides an admirable means of producing sound strong castings from high-phosphorus cast iron. It is, of course, generally applied to simple castings, such as cylinder liners in which P of 0.9 per cent. is regularly used, and it can also be applied in conjunction with composite assemblies where centrifugally cast bushes or liners may be incorporated.

A particularly interesting example is in the centrifugal casting of trench-mortar bombs, though, of course, this practice is limited in its scope, as it calls for special plant. A firm, arising out of their experience in the manufacture of centrifugal cast pipe using Derbyshire iron, conceived the view that the adoption of the centrifugal casting process for the production of bombs would enable such castings to be produced in phosphoric iron to meet the requirements as to freedom from porosity. A centrifugal casting process has been developed specially for the production of these castings.

The mould, incidentally, itself made from 66 per cent. Derbyshire pig and 33 per cent. returned scrap, is arranged to rotate about its vertical axis, and corresponds to the external shape of the bomb casting. It is split along a horizontal plane corresponding to the point of maximum external diameter of the bomb, and so arranged that the bomb is cast with the open end down and the solid end up. An oil-sand core is used. The mixture of iron used for the bombs consists of Derbyshire pig-iron, returned scrap and scrap from the vertical cast-pipe foundry or the spun-pipe foundry on the same plant. The approximate chemical composition of the finished bombs is as follows: Si, 2 to 2.1 per cent.; P, 1 to 1.3 per cent.; and Mn, 0.4 to 0.45 per cent.

The percentage of rejects due to porosity is negligible, and would not amount to a fraction of 1 per cent. The bombs are tested to 1,000-lb. hydraulic pressure at the works in the "as-cast" state, and to 100-lb. air pressure submerged in water after machining.

(To be continued.)

American Die-Casting Prices.—To prevent a rise in prices of die-castings, 1942 sales of which in America totalled more than $90,000,000, the Office of Price Administration has frozen these prices at the lowest levels between April 1, 1942, and April 30, 1943. These castings at present are made principally of aluminium and magnesium, and are used for starters, automatic pilots, brackets and other non-structural parts of aircraft and automotive equipment, and for fuses and other components of ammunition. In peacetime die-castings were made mainly of zinc and put to many everyday uses. Last year zinc die-castings were only 35 per cent. of the whole output.

HOT TEAR FORMATION IN STEEL CASTINGS

By CHARLES W. BRIGGS

(Technical and Research Director, Steel Founders' Society of America, Cleveland, Ohio)

American Foundrymen's Association Exchange Paper presented at Annual Conference of Institute of British Foundrymen on June 26

(*Continued from page* 282.)

Strength of Steels at Hot Tearing Temperatures

It has been stated that hot tears form at high temperatures. What are these temperatures? What are the mechanical properties of cast steel at these temperatures?

Prior to 1928 much had been said concerning hot tears and how to prevent them, but little was known of the actual conditions of hot tearing, such as the cracking temperature or the magnitude of the stresses causing hot tearing. In 1928, Körber and Schitzkowski[7] produced hot tears in flanged bars by hindered contraction and decided that the critical temperature at which hot tears are most liable to be formed was about 2,300 to 2,400 deg. F. They did not, however, measure the stresses on the bars at the time of hot tearing. In 1932 and 1934, Briggs and Gezelius[8,9] made a study of the stress acting on a bar during hindered contraction. These bars did not break under the hindered contraction applied, as they were so designed as to prevent points of stress centralisation. Since the bars did not break, this work did not show the actual amount of stress necessary to cause hot tears at the hot tearing temperature, but it did show the load-carrying ability of steel under hindered contraction.

In 1936 and 1938, Hall, [9,10] of Woolwich Arsenal, presented data on the strength and ductility of steel at temperatures near the melting point. In the region of 2,300 to 2,400 deg. F. he showed that the ultimate stress necessary to cause failure in 1-in. bars averaged, for cast carbon steel, from 1,700 lbs. per sq. in., at 2,370 deg. F., to 2,500 lbs. per sq. in. at 2,280 deg. F. There is no indication from this work that the temperature range of 2,300 to 2,400 deg. is more conducive to the formation of hot tears than any other temperature range. In fact, the temperature-ultimate stress curves show nearly a straight-line relation, in that there is practically a uniform increase in the ultimate strength as the temperature drops.

In Fig. 14 there are presented curves showing the strength of different carbon cast steels at elevated temperatures.[9] The curves indicate that the increase of strength with the decrease of temperature is nearly a straight-line function, and that the lower the carbon content the greater is the strength at any given temperature. There does not appear to be much difference between the values of the 0.25 and 0.42 per cent. carbon curves. This apparently indicates that, as the carbon content increases, the strength differential diminishes rapidly. It would appear from these curves that the higher the temperature, the lower the tensile properties, and hence the easier to obtain hot tear formation.

The elongation values of the different carbon steels at the high temperatures is presented in Fig. 15. The curves show that as the carbon content increases the ductility decreases for any particular temperature. Also, the greatest differences in ductility occur at the lower carbon content. An interesting point is, however, presented by these curves, namely, that for the carbon contents normally produced in commercial practice (0.20 to 0.40 per cent. carbon) the ductility is very low until a temperature of approximately 2,350 deg. F. is reached in the cooling cycle.

Since there is little or no ductility in normal content carbon steels until a temperature of 2,350 deg. F. is reached, then only a small amount of deformation is necessary to be responsible for hot tear formation. Also castings that have failed because of hot tears exhibit sections the fractures of which show no evidence of plastic deformation.

Ductility is, therefore, a very important property in hot tear occurrence. It may be even possible to go a step further and state that it appears that the property of ductility is more important than strength in the consideration of hot tear formation. If this is so, then temperatures can be fixed below which hot tear formation will probably not take place. For carbon contents of 0.25 to 0.40 per cent., temperatures of 2,350 to 2,300 deg. F. would constitute the lower range of hot tear formation. Hot tears, therefore, may form at any temperature between these temperatures and the solidification temperature of the steel.

Because of the increased ductility of low-carbon steels (carbon contents below 0.20 per cent.), the range of hot tear formation would be smaller by approximately 200 deg. F., in that ductility values have reached an appreciable figure at 2,500 to 2,550 deg. F. This would allow an approximate temperature range of only 175 to 225 deg. F. for hot tear formation for a 0.10 to 0.15 per cent. carbon steel, while for the 0.25 or 0.42 per cent. carbon steel a range of approximately 325 deg. F. is available for hot tear formation. This, of course, applies to 1-in. dia. sections, and all temperatures recorded are skin temperatures.

Variations in temperature between the exterior and interior of a section brings up another point regarding the strength and ductility of cast steel at high temperatures. In steel castings that solidify and cool in the normal way a temperature gradient exists

Hot Tear Formation in Steel Castings

between the temperature of the skin and the temperature of the centre of the bar. It is, therefore, necessary, when reporting property values, that either the skin temperature or the centre temperature must be used in plotting the results. The temperature is responsible for the recording of different values if different size bars are used in the test studies. Since the skin is at a lower temperature than the centre of the bar, and since the lower temperature steel shows the higher property values, it must follow that the ratio of the area to the circumference of the bar is important in the magnitude of the values obtained.

This point is fairly well substantiated in Fig. 16, which shows the properties of 0.25 per cent. carbon cast steel as tested by Hall[8] on a 1-in. dia. bar and

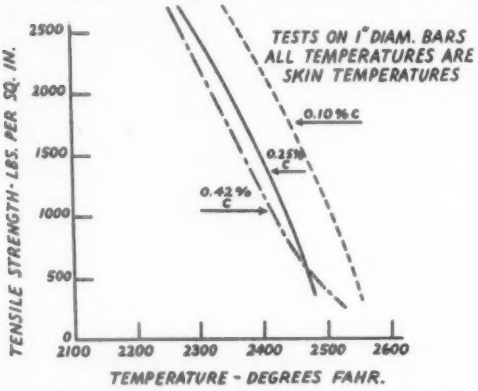

FIG. 14.—STRENGTH OF CARBON CAST STEELS AT HIGH TEMPERATURES.

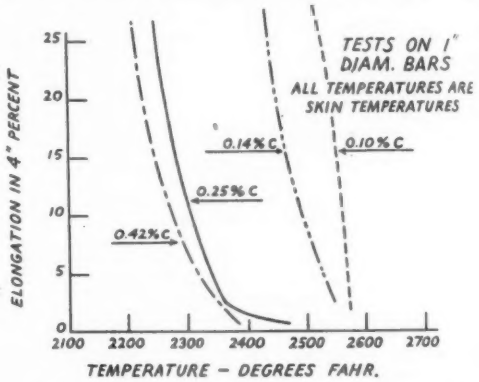

FIG. 15.—DUCTILITY OF CARBON CAST STEELS AT HIGH TEMPERATURES.

as obtained by the author on a $1\frac{18}{32}$-in. dia bar. This ratio on the two bars is as follows:—

Diameter.	Area.	Circumference.	Ratio.
1 in.	0.79 sq. in.	3.14 in.	0.25
$1\frac{18}{32}$ in.	2.00 sq. in.	5.00 in.	0.40

From these figures it would appear that, as the area increases with respect to the circumference, the effect of the skin on the test values is not as pronounced. The curves of Fig. 16 tend to prove that this condition actually exists.

The reason for discussing this point is that when mention is made of the magnitude of stresses at the hot tearing temperatures, it will not be necessary to develop stress forces equal or greater than the tensile strength values as set forth in the results presented by Hall. In fact, the strength of a 1-in. section in a casting whose width was greater than 1 in. would be less than the values shown by Hall since the ratio of area to the circumference increases as the width increases. This condition is also true in section thicknesses that are greater than 1 in.

Magnitude of Stress Due to Hindered Contraction at Hot Tear Formation Temperatures

It is known[3] that a 0.35 per cent. carbon steel in the temperature range of hot tearing (2,630 to 2,300 deg. F.) will develop stress loads under various types of hindered contraction, as shown in Table I. These figures would tend to indicate that even under the most drastic conditions of hindered contraction, the stresses developed during the hot tear formation temperature interval would not be sufficiently high enough to cause failure if the values of Hall are used as a basis of comparison. It will be remembered that he showed values in the neighbourhood of 2,000 lbs. per sq. in.

TABLE I.—*Stress Quantities at High Temperatures.*

Stress, lbs. per sq. in.			Type of hindered contr.	Per cent. Contr. at room temp.
2,500 deg. F.	2,400 deg. F.	2,300 deg. F.		
105	210	340	Light	1.7
335	500	625	Medium	1.0
385	560	730	High	0.5

as the tensile strength of medium carbon steel at 2,300 deg. F. for a 1-in. dia. bar. But it is known that castings do tear at these temperatures, and as has already been pointed out, sections in castings will not exhibit these high strength values.

Tensile strength values at elevated temperatures of

medium carbon cast steel that had previously cooled to room temperature has been reported[11] to be 250 to 230 lbs. per sq. in. at 2,250 deg. F. These figures are more in line with the stresses developed by hindered contraction, but it is felt that not too much significance should be placed on these figures since the temperature gradients usually found in steel castings were not present. There is one thing that should be pointed out, and that is, the rate of testing used was much slower than that used by Hall, and therefore more in line with the rate at which hindered contraction stresses are built up.

Even though the tensile values that Hall shows are not applied to practical application, the actual values of casting section strengths at high temperature are undoubtedly still greater than the amount of stress de-

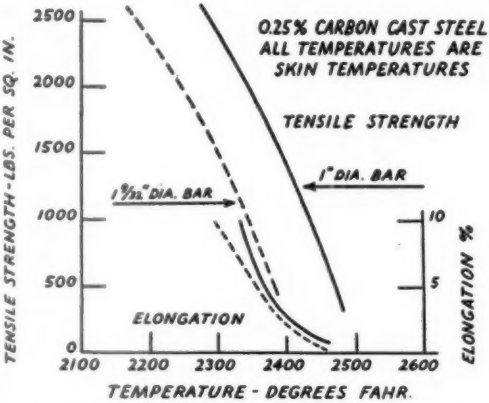

FIG. 16.—EFFECT OF SIZE OF TEST-BAR ON THE STRENGTH AND DUCTILITY OF CARBON CAST STEELS AT HIGH TEMPERATURES.

veloped by hindered contraction at the same temperature. The realisation of this fact requires that a further consideration be made, namely, that stress concentration is responsible for the apparent discrepancies so that tearing does occur in accordance with practical observations.

It is quite possible that with the differential cooling of a casting, and because of hindered contraction due to mould resistance, stresses will concentrate at a hot spot in the casting, with the result that the casting will tear. The hot spot may have a temperature approaching 2,500 deg. F., while other parts of the casting will be at temperatures of 2,250 to 2,300 deg. In such a situation stresses of 250 to 500 lbs. per sq. in. could arise through hindered contraction, which if concentrated at the 2,500 deg. F. hot spot would be, even according to the high values reported by Hall, a stress load sufficient to cause hot tearing.

Thus, it is possible that small tension or shear stresses as developed by hindered contraction are responsible for hot tear formation, providing that the hindered contraction present is greater than that normally allowed under "patternmaker's shrinkage."

Hindered Contraction Stresses Produced by Sands and Cores

It is quite easily seen that casting design can be responsible for the stresses shown in Table I. which is a brief summary of the results found by Briggs and Gezelius.[3] But what is perhaps more difficult to understand is that sufficiently high stresses can be set up through hindered contraction due to sand mould and cores, and thereby causing hot tear formation. It can, however, be demonstrated that sands and cores can provide, at elevated temperatures, sufficient hindered contraction which is greater than that normally allowed under "patternmaker's shrinkage."

Studies[15] conducted on the hot strength of mould-

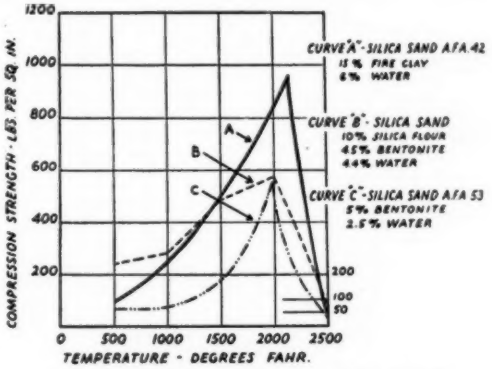

FIG. 17.—THE HOT STRENGTH OF VARIOUS SAND MIXTURES.

ing sands and cores show that certain mixes develop very high strengths at the elevated temperatures, as is shown in Fig. 17. Some sands develop strengths of over 1,000 lbs. per sq. in. in the neighbourhood of 2,000 deg. F. It is true they drop off to values of 5 to 100 or so lbs. per sq. in. at temperatures near 2,500 deg. F. But all these strengths are found in a sand under the actual conditions of casting, since there is a very pronounced temperature gradient that exists following the casting of the steel.[16] Thus, while the sand at the mould-metal interface is at a temperature of about 2,500 deg. F. and has a strength of perhaps 20 lbs. per sq. in., the sand at only $\frac{1}{4}$ in. away from the mould-metal interface would be at about 2,000 to 2,200 deg. and have a possible strength of 1,000 lbs. per sq. in. Sand of these high strengths will, of course, tend to prevent the normal contraction of the casting, with the result that hindered contraction stresses are formed.

Hot Tear Formation in Steel Castings

From the work that has been done it has been established that for steel castings the maximum hot strength at 2,500 deg. F. for sands probably should not be over 25 lbs. per sq. in. If this figure is exceeded by very much the possibilities of hot tearing of the casting increase. Thus, sands and cores as well as casting design can be responsible for the formation of high hindered contraction stress at elevated temperatures.

The Susceptibility of Various Cast Steels to Hot Tear Formation

At any gathering of steel foundrymen where the subject of hot tears is discussed, sooner or later the discussion will turn to a debate as to which of the two types of cast steel, high carbon or low carbon, are

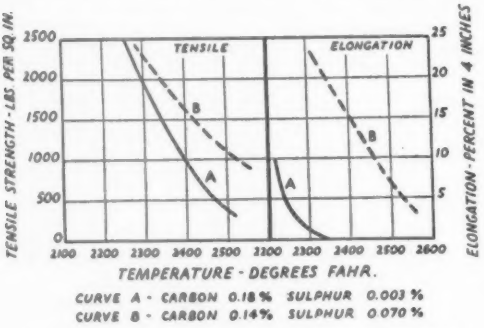

FIG. 18.—EFFECT OF SULPHUR ON THE STRENGTH AND DUCTILITY OF CAST STEELS AT HIGH TEMPERATURES. (HALL.)

less susceptible to hot tears. The discussion may also include acid *v.* basic steel melting practice as concerning susceptibility of hot tear formation. Opinion among foundrymen is about equally divided on these subjects.

The odd thing is that during these discussions the subject of stresses or stress formation is seldom considered. Perhaps it is taken for granted, though it is believed that the subject is of such importance that it can hardly be taken for granted. For without the presence of stress there will be no hot tears in well-fed sections, regardless of the composition of the steel or the manner in which it is made.

In the first place, the two steels cannot be directly compared. Two similar castings produced under similar conditions will not be under the same hindered contraction stresses at a common temperature. For example, it is assumed that one casting is produced from 0.15 per cent. carbon steel and that another similar casting is poured from 0.45 per cent. carbon steel. At 2,300 deg. F. under hindered contraction conditions a stress of 750 lbs. per sq. in. on the 0.15 per cent. carbon steel can be expected, whereas under the same conditions of hindered contraction the 0.45 per cent. carbon steel will have a stress of approximately only 500 lbs. acting upon it.[9]

Because of the higher stress acting upon the low-carbon steel, the natural reaction would be that the low-carbon steel is more susceptible to hot tears. However, this is not the entire story. It must be remembered that the low-carbon steel has a much greater strength and ductility at 2,300 deg. F. than the higher carbon steel. If values established by Hall[9] are used, as they can be considered comparative regardless of the section considered, the low-carbon steel is 1.4 times the tensile strength and eight times the ductility value of the high-carbon steel at 2,300 deg. F. Also, the hot tear formation temperature range is considerably smaller than that of the higher carbon steel. Thus, the two types of steels cannot be compared directly as to which is the best from susceptibility to hot tears.

In some cases the high-carbon steels will be less susceptible to hot tears, while in other cases the low-carbon steels will resist hot tear formation more effectively. Which steel to use to obtain the best results will depend on the mould conditions and the casting design. It must be remembered that hindered contraction can arise due to conditions of the mould, such as hard moulds and cores, or it may reach considerable proportions because of the casting design alone. It is suggested, however, that the low-carbon steels be first used if excessive hot tearing is encountered, since strength and ductility at high temperatures are necessary to combat stress concentrations at weak sections which are at higher temperatures than other sections.

If, however, the basic *v.* the acid practice is considered as to hot tear formation susceptibility, it is not believed that this can be treated quite so controversially. Inclusions, their content, type and characteristics, as present in a cast steel, have considerable influence on the mechanical properties of the steel at the very high temperatures. It is known that sulphur is quite an active inclusion former, and its presence under certain conditions can lead to the formation of quite harmful inclusion types.

Thus, it would seem that anything that could be done to keep the sulphur content as low as possible would be a step in the right direction regarding the susceptibility to hot tear formation. It has been shown that, as the sulphur content increases, the strength and ductility of cast steel at high temperatures falls off extensively[10] (Fig. 18). By the use of the basic practice, it is possible to keep the sulphur content to a low figure. Thus, it would seem that things other than sulphur content and inclusion count; being equal, basic steels are less susceptible to hot tear formation than acid steels.

Cast steels having a sulphur content greater than 0.03 per cent. will show upon deoxidation with a critical amount of aluminium (0.05 per cent.), an extensive chain-like eutectic pattern of inclusions.[12]

Such a condition results in low ductility properties in castings. If the sulphur content is in the neighbourhood of 0.02 per cent., there is but little effect of low ductility upon deoxidation with small amounts of aluminium. Low ductility and low strength properties are obtained at high temperatures and are more pronounced than those recorded at atmospheric temperatures. Thus, from the standpoint of hot tear susceptibility, the sulphur content should be kept low, preferably below 0.025 per cent.

High contents of phosphorus (0.07 per cent.) lowers the strength and ductility of cast steels at high temperatures, but normal phosphorus contents below 0.05 per cent. do not have much effect on the high or atmospheric temperature properties of the steel.[9]

Inclusion Types

Certain inclusion types present in cast steel are conducive to the formation of hot tears.[8] Five types of inclusions have been recognised in cast steel in Table II, together with their sensitivity toward hot tear formation.[14]

TABLE II.—*Types of Inclusions and Sensitivity Toward Hot Tear Formation.*

Type.	Non-metallic inclusions.*	Hot tear sensitivity.
Silicate ..	Glassy silicates, round sulphides, and (intergranular sulphide films)	Prone to hot tear.
Eutectic	Round sulphides and intergranular sulphide films (alumina)	Prone to hot tear.
Galaxy ..	Alumina, round sulphides and films of oxide galaxies (inter-granular sulphides)	Less sensitive.
Alumina	Alumina, round sulphides, and (intergranular sulphide films or oxide galaxies)	Resistant to hot tears.
Peritectic	Alumina, duplex, round sulphides and (intergranular sulphide films)	Resistant to hot tears.

* Parentheses indicate appearance only in small amounts

The proneness to hot-tearing of cast steels of the silicate and eutectic types is explained by the fact that atmospheric oxidation produces eutectic inclusions at the surface of the casting, which seriously lowers the resistance of steel castings to hot-tearing. The intergranular sulphide form of the ternary eutectic is considered to be more prone to allow hot-tearing than the oxide galaxy form. The presence of the galaxy eutectic adjacent to the oxide phase makes the galaxy type of steel less sensitive to hot-tearing than the silicate or eutectic types.

The alumina and peritectic types are somewhat more resistant to hot-tearing at the oxidised surface owing to the formation of separated oxide particles rather than continuous intergranular films. Steels of the peritectic type (deoxidised with calcium) seem to have the same degree of resistance to hot-tearing that has been found in the strongly deoxidised steels that are not treated with calcium.

These remarks on inclusion types should be looked upon only as trends that may exist, for the other factors that are discussed in this Paper require greater consideration. The use of a certain type of deoxidiser is not going to make the steel relatively resistant to hot-tearing.

Influence of Pouring Temperature on Hot Tears

The temperature of the steel as it enters the mould is not directly a responsible factor for hot tear formation. Indirectly, however, temperature may be a factor. This may appear to be somewhat confusing. What is meant is that, if two steels are poured into similar moulds, one a high-temperature steel, the other a low-temperature steel, the high-temperature steel will not be more conducive to hot tears than the low-temperature steel. The reason for this is that hot tears do not form until the steel has solidified, and it is necessary for the hot steel to become cool steel before it solidifies. Therefore, there is no difference in the metal characteristics of the two steels as far as favouring hot-tearing.

Temperature can, however, bring about altering conditions in mould temperature gradients, and casting design may be such that temperature of the steel contributes to hot tear formation.

It is known that large uniform section castings should be poured on the cold side or as cold as the running of the mould will allow. In doing this the mould is not unduly heated at certain places to form hot spots in the casting. Points of change in sections are chilled to prevent hot spot formations and possible locations for hot tears. Castings of this design and type will probably develop hot tears if poured with high temperature steel.

This does not mean that all castings poured with high temperature steel are susceptible to hot tear formation. In fact, by the use of high temperature it is equally possible to prevent hot tear formation and at the same time prevent the formation of shrinkage cavities. If the casting is properly designed to allow for controlled directional solidification,[1] then every possible attempt should be made to establish large temperature gradients within the mould and casting. One of the best ways to do this is to use high temperature steel. Thus, the effect that temperature has on hot tearing depends entirely upon the casting design and mould construction.

Alloy Steels

In this discussion nothing has been said regarding alloy steels and how they react towards hot tear formation. Like carbon steels, the amount of strength and ductility that an alloy steel possesses at temperatures near the solidification temperature, and the rate at which it contracts under hindered contraction will in all probability determine its position as to its ability to resist hot tears. It is suggested that a comparison be made of a nickel-chromium cast steel of 0.35 per cent. carbon content with a plain carbon cast steel of the same carbon content. It is universally held that a nickel-chromium steel is quite susceptible to hot tear formation.

Hot Tear Formation in Steel Castings

From information presented[9] it is possible to observe that nickel contents of from 2 to 5 per cent. do not increase the tensile strength or ductility of carbon steel at any particular high temperature. Chromium in percentages of around 1 per cent. appears to definitely lower the property values, while the combination of nickel-chromium reduces the values below those recorded for chromium. If a few values are singled out for both carbon and nickel-chromium steels of the same approximate carbon content, the values in Table III are obtained.

TABLE III.—*A Comparison of Carbon and Nickel-Chromium Cast Steel Strength at High Temperatures.*

Deg. F.	Carbon cast steel.		Nickel-chromium cast steel.	
	Tensile strength, lbs. per sq. in.	Elongation in 4 in. per cent.	Tensile strength, lbs. per sq. in.	Elongation in 4 in. per cent.
2,500	400	0	60	0
2,400	1,300	0.5	380	0
2,300	2,000	7.0	840	0
2,200	3,200	33.0	1,900	15

From these figures it can easily be seen that the nickel-chromium cast steels are much lower in strength and ductility than a corresponding plain carbon steel. Also the hot tear formation temperature range is longer.

There appears to be but little difference in the rate of hindered contraction of carbon and the nickel-chromium cast steels,[8] and hence the rate at which the stress is built-up is practically the same. Under a hindered contraction that may be normally expected in casting manufacture a stress of approximately 500 lbs. per sq. in. may be obtained at 2,300 deg. F. This is very close to the 840 lbs. per sq. in. at zero elongation as shown for the properties of the nickel-chromium steel as compared to the values of 2,000 lb. per sq. in. and 7 per cent. elongation for the carbon steel. Hence, it is easy to see that the nickel-chromium cast steels are very susceptible to hot tear formation.

It has been stated previously that solidification contraction may be responsible for the formation of hot tears. The information on the amount of solidification contraction in various steels is rather limited, and one is called on to make certain assumptions after reviewing all the assembled data on specific volume values. Thus, it appears that the total solidification contraction of a nickel-chromium steel would be perhaps greater than that of the carbon steel. If there has been no error in this deduction then poorly fed nickel-chromium steel would be more susceptible to hot tear formation (contraction cavities), due to insufficient feed metal, than the plain carbon cast steel.

Looking at the problem from these two viewpoints it is easy to see why the nickel-chromium combination is disliked in the foundry. It might be quite possible to continue at some length on the possibilities of various steels as regards their hot tear formation susceptibility, but a considerable amount of the information would be based on general trends instead of actual data. More important information could be obtained if steel foundrymen could carry out additional correlated testing. This would mean that some type of a test must be developed for hot tear susceptibility.

Hot Tear Prevention Measures

The best method of preventing hot tears is to keep hindered contraction stresses to low values. If hindered contraction values are greater than normal patternmaker's shrinkage ($\frac{3}{16}$ in. per ft.) hot tear formation is a distinct possibility.

Measures that should be undertaken to prevent hot tear formation are as follows:—

(1) Stresses that result from the hindered contraction of castings due to high strength moulds and cores should be kept at a low value. Do this by using relieving blocks or friable material in the backing sand, or by the use of low strength sand for the cores as tested at elevated temperatures.

(2) See that castings are so designed that they will not be closed, stress active systems wherein temperature gradients may be responsible for large stresses.

(3) Make ample allowances for solidification contraction so that every section may be well fed.

(4) Produce high quality steel of low inclusion content and of proper inclusion type.

(5) Apply proper chills to changes in sections to prevent hot spot formation.

(6) Use ribs, or cracking strips, at places to assist in preventing stress concentration.

(7) Keep the pouring temperature consistent with the steel casting design.

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HINTS ON FOUNDING LOW-CARBON CAST IRON*

By J. W. NICHOLLS

During the past 12 years rapid progress has been made in the development and production of high-strength cast irons, both plain and alloyed, with tensile strengths as high as 36 tons per sq. in. Due to this increased strength, coupled with the greater shock resistance, components manufactured in these high-strength irons have found, and are finding, their way into the iron foundry.

The lowering of total carbon content, plus in many cases the beneficial effect of inoculation on the graphite carbon distribution, accompanied by the strengthening of the ferrite matrix by the addition of alloying elements such as nickel, chromium and molybdenum, either singly or in combination with one another, have been mainly responsible for this marked increase in the mechanical properties obtained. It should be borne in mind, however, that low-carbon irons have a tendency to develop dendritic graphite, which, if formed, offsets its advantages of low carbon.

Low Carbon—Poor Fluidity

The production and founding of these cast irons has necessitated certain fundamental points being observed, and greater care taken both in melting procedure and moulding technique, to ensure sound and dense castings of the required strength being produced, the primary reason being such high strengths are usually associated with a total carbon content within the range of 2.6 to 2.9 per cent.

With any one class of iron it can safely be said (other factors being considered, of course) that the lower the carbon the higher the strength, but this lowering of the total carbon results in the production of an iron possessing a higher solidification point, coupled with a greater freezing range, or "pasty" range; and therefore, compared with an ordinary grey cast iron at a corresponding temperature when molten, it is less fluid. This decrease in fluidity is further aggravated by the fact that such high strength irons contain a low percentage of phosphorus, although it can be somewhat compensated for by the fact that such irons are less sensitive to silicon variation, and therefore higher silicon can be used.

The poor fluidity properties mentioned have increased the foundryman's problems; first because such irons possess increased shrinkage characteristics, and, secondly, in order to counteract the poor fluidity, higher casting temperatures must be adopted. Thus, as mentioned previously, greater care must be exercised in melting, moulding, and casting to ensure soundness.

Source of Trouble

The main points on which attention must be focussed can be classified as follows:—(1) Metal composition and melting technique; (2) sand properties and condition of mould, and (3) types and methods of placing gates and risers. A recent Paper before this Institute gave a full and comprehensive survey of (1), and therefore only general points will be mentioned.

The total carbon content is undoubtedly the most important element, and variation in the amount present usually occurs through incorrect cupola operation, a higher carbon pick-up resulting from too slow a melting rate, and far too long a period between the tapping operation. Too rapid a melting, on the other hand, may cause heavy oxidation of the iron and elements present, due to over-blowing.

Incorrect charging methods can result in composition variations, inasmuch as short intermittent tapping is necessary. The tapping of dull metal can be caused by the bed coke being too low and/or insufficient coke split, and/or insufficient blast. Such metal will not respond to inoculation as effectively as superheated iron, and, of course, rapidly loses whatever fluidity it possesses. To aid in maintaining a good casting temperature for all castings, always preheat the ladle, and arrange for the handling of the metal to be carried out as quickly as possible, skim the ladle efficiently from the opposite lip to that used for pouring, and, when pouring, avoid splashing, as this may result in the formation of hard spots and blowholes.

Sand Properties and Conditions of Mould

Owing to the necessity of casting these irons at higher temperatures than normally encountered, any disturbances in the mould caused by dampness, hard or soft ramming, and poor venting, greatly intensify the possibilities of resulting defect. The shorter life of the metal in the mould reduces the time in which gas and steam bubbles can escape.

One important point, and one which results in the production of a large percentage of "wasters," is the use of green-sand runner bushes, and the presence of moisture in the ingates. Therefore, use dry sand or core-sand bushes, and make certain that the mould, runners, and ingates are all perfectly dried. One source of dampness in the ingates is that during the drying of the mould by pans, steam may find its way into the gates, where it condenses.

During the construction of the mould itself, avoid exeessive use of the "swab" when withdrawing the pattern, as this can result in a weakening of the sand at the sharp edges or corners, resulting in a possible breakage of the sand during the casting operation. Further, make certain that all loose sand in the mould, runners, and bushes adhering to the cores is removed. Any sand or moisture present in, or carried into, the mould has little chance of escaping owing to the rapid fall in the fluidity of the metal, thus resulting in such defects as sand holes and blowholes.

The higher casting temperatures used necessitate the use of a facing sand with reasonable refractory properties, certainly higher than the refractories of some sands used for standard work. The rapid fall in fluidity of the metal demands that sands used

* Prize-winning Essay in a Competition organised by the West Riding of Yorkshire Branch of the Institute of British Foundrymen.

Founding Low-Carbon Cast Iron

both for moulding and core making must be as open and as free venting as possible, consistent with good dry strength, thus ensuring a rapid escape of gases.

The use of ill-conditioned sand, that is, possessing low dry strength and poor permeability, is another source of blow-hole and sand-hole defects. In fact, several so-called shrinkage defects can often be traced to the permeability of the sand, and can, in some cases, be cured by the use of a vent wire.

Inasmuch as low-carbon irons possess a strong tendency to dissolve carbon at the casting temperature. some attention should be given to the composition of the moulding face wash, and it is recommended that, in order to produce a good skin finish on the castings, the wash contain less carbon and more siliceous material than normally used.

Type and Methods of Placing Gates and Risers

One problem with these irons is to guarantee soundness in castings, particularly where any variation in sections occurs. As is well known, wherever such changes in section take place, porosity or draws may occur, and whilst metallurgical control and moulding methods can greatly counteract this tendency, normally, thinner sections solidify more rapidly than the thicker sections, with the possible formation of either small holes or more open grain metal at the changes in sections. Great importance is therefore attached to the method of "running" and "rising" for low-carbon irons.

To reduce this defect to a minimum, a scientific examination of the pattern should always be carried out before moulding, to decide the method of running. Shrinkage is a problem which does not allow one to state any one definite method for overcoming it, design of the casting usually deciding the method to be used. Always aim, however, at promoting equal and progressive solidification by judicious running and feeding of the casting.

There must always be an available supply of liquid metal to feed those parts of the castings last to solidify. Avoid wide variations in the temperature of the metal in the various sections of the castings, and to assist in this, use can be made of denseners and/or running through the thin sections so that the colder metal fills the thicker sections.

Feeding of certain types of heavy castings can be brought about by use of self-feeding heads; use risers of suitable size and shape, placed in positions whereby final shrinkage will take place at the location of the riser. In some cases this can be assisted by tapping the risers with hot metal. Avoid the use, however, of risers which will solidify before the casting directly beneath, and avoid rod feeding, as this tends to drag iron from the mould.

Head pressure is an important factor in promoting soundness, and this can be achieved by the use of copes of greater depth with higher risers. The method of gating adopted will depend on the type of casting being made, bearing in mind that low-carbon iron will not run the same distance as ordinary iron, and with heavily cored castings pouring should be at such a rate that will allow the vents ample time to operate. Avoid running a large volume of metal through one gate, and distribute the gates, particularly if making a heavy casting. Further, in placing of the gates, make use of strainer, whirl and choke gates wherever possible, as these are effective in mechanically cleansing, by preventing dirt or dross from entering the mould.

Finally, there are many castings on which risers may be eliminated, but usually these are of a uniform section, and in running such castings greater care must be exercised over the rate of filling the mould and the temperature of the iron.

Discussion

MR. S. CARTER, opening the discussion, asked if the author had any practical proof of his observations on absorption of carbon from the mould face. Personal experience was that the metal, as it was poured, froze so quickly that a skin formed, and there was practically no absorption of carbon at that point.

MR. NICHOLLS said he agreed in a measure, but there must be certain parts of the melt at which there was a continuous flow of metal and not the skin which Mr. Carter mentioned, and there occurred the possibility of dissolving carbon. He had found it at such positions, but not, he agreed, on the whole casting. Whilst he had no definite proof, yet from pourings of castings where there was a large volume of metal passing over the surface, there was every appearance that that happened. He had found that the best type of iron appeared to have the least carbon pick-up. Whether that was due to the blast conditions being ideal or to the matter of the coke, he could not say. A good deal, he thought, depended on the surface area, on which metal droplets must pass through before reaching the well. He had encountered cases showing the presence of "hair cracks" in thin sections of low-carbon castings. They were, he felt, more or less due to the fact that low-carbon irons had a strong tendency to oxidise, and one came across the cracks due to the thin film of oxide at that point. In answer to Mr. Forrest as to the effect of silica washings indicating a tendency towards cold spots, Mr. Nicholls said he had no actual experience in that regard, but he would think, if the silica and carbon were balanced in the right proportion, there should not be any seal formed over the pores of the sand.

Atmospheric Pressure Feeding

MR. J. BLAKISTON, remarking that the author had illustrated on the blackboard the method of feeding a heavy block section of iron and how it would be converted into atmospheric pressure feeding, said he would like Mr. Nicholls to emphasise for general information that there was no necessity to have direct risers over the block.

MR. NICHOLLS—again using the blackboard—said one could utilise a small sand core which must pene-

(*Concluded overleaf.*)

HINTS ON FOUNDING LOW-CARBON CAST IRON

(*Concluded from previous page.*)

trate into the pores of the mould. An oil-sand core, when in direct contact with the sand, if in direct contact with the atmospheric pressure, would allow additional pressure acting on the feed of the metal as it travelled over the mould. The atmospheric feeding, he suggested, was a point well worth studying by anybody interested in the density of iron. He agreed with Mr. Blakiston that there was no necessity to have any direct risers.

MR. W. G. THORNTON said he would have imagined the core would collapse before it had the effect of atmospheric pressure. There would still be the excess portion outside in contact with the metal.

MR. NICHOLLS said there was an article in THE FOUNDRY TRADE JOURNAL some months ago on atmospheric pressure feeding in regard to steel castings, and he thought it might be helpful in reference to this matter of low-carbon irons.

In answer to a member's comment, MR. NICHOLLS said the question of the position of runners and risers was a matter to be determined by the individual on the particular job. He must determine his own method which on experience he found would give the soundest job, and it was not practicable to lay down any hard-and-fast rule on the point.

Replying to another member, MR. NICHOLLS said, in reference to carbon pick-up in the furnace, much depended on the actual carbon content of the iron being melted. The higher the steel charge, the higher the carbon pick-up at high temperature, but much undoubtedly depended on the actual composition of the metal, and the size of the coke decided the contact of the metal in its passage from the melting zone down to the furnace.

OBITUARY

MR. DOUGLAS JOHN HAINES, chairman of Westley, Richards & Company, Limited, gunsmiths, Birmingham, died in tragic circumstances recently. He was 70 years of age.

MR. JAMES KAY, formerly assistant general manager of C. & W. Walker, Limited, Midland Ironworks, Donnington, near Wellington, Shropshire, died recently, aged 67 years.

MR. JOHN RITCHIE, managing director of Mackenzie & Moncur, Limited, ironfounders and heavy engineers, of Edinburgh, died recently. He joined the firm as a general assistant over forty years ago.

AT APRIL 12, the latest date for which Ministry of Labour figures are available, there were 76,769 persons aged 14 and over registered at employment exchanges in Britain as wholly unemployed (excluding 21,669 persons classified by interviewing panels as unsuitable for ordinary employment); 1,312 registered as temporarily stopped; and 2,010 registered as unemployed casual workers.

AN EFFICIENT HEAVY ENGINEERING INDUSTRY

Presiding at the recent annual meeting of the Wellman Smith Owen Engineering Corporation, Limited, Sir Samuel Roberts, Bt. (chairman), commented on the election to the board during the year of Sir Walter Benton Jones, Bt. (chairman of the United Steel Companies, Limited), Mr. Allan C. Macdiarmid (chairman of Stewart and Lloyds, Limited), and Mr. John E. James (chairman of the Lancashire Steel Corporation, Limited). He said that these three companies had each bought comparatively small holdings of Wellman Smith Owen shares, not sufficient to give them anything like a controlling interest.

This was in furtherance of a policy (approved by the Iron and Steel Federation) for the steel companies to interest themselves in seeing that there should be in this country after the war an efficient heavy engineering industry, with knowledge and capacity sufficient to supply the needs of the steel industry, said Sir Samuel Roberts. This, together with the steel companies' similar connection with Davy & United Engineering Company, was the first step in a movement that he believed was in the national interests, as before the war the steel industries were largely dependent for their engineering requisites on the Continent of Europe and the United States. He wished to make it clear that the scheme was not an exclusive one, either as to the steel companies or engineering companies at present involved. They fully understood that they would obtain no special preferences, and that they must still depend on their efficiency and on their prices being competitive.

FOUNDRY WORKERS' CONFERENCE

At a conference of the National Union of Foundry Workers at Manchester, last week, a proposal to admit women to membership was discussed, and the national council was instructed to examine the position and put its views before the members, who will then be asked to vote on the question. Large numbers of women are being introduced into the foundries and it was argued that the task of organising them to safeguard their wages and conditions had become urgent. One union for foundry workers, instead of ten as at present, was another proposed reform which received unanimous support. The conference decided to put before the National Wages Negotiating Committee an application for a 15s. a week increase all round, and to press now for a 40-hr. working week after the war.

DAVID BROWN & SONS (HUDDERSFIELD), LIMITED, iron, steel and non-ferrous founders, engineers, etc., announce that Lord Brabazon, Sir Arthur Matthews, Sir Alexander Dunbar and Mr. Walter Haydn Child have been elected directors, in addition to Mr. David Brown, Sir Ernest Roney and Mr. W. Killingbeck. Lord Brabazon has been elected chairman, and Mr. David Brown continues as managing director. These appointments have the approval of the Ministry of Production.

NEWS IN BRIEF

THE ADDRESS of the London office of the Paterson, Hughes Engineering Company, Limited, is now Bedford House, Bedford Street, Strand, W.C.2. (Tel.: Temple Bar 7274.)

SPEAKING AT a meeting of the Teesside Chamber of Commerce at Middlesbrough, Mr. W. M. McCormack, president of the Power-Gas Corporation, Limited, Stockton-on-Tees, suggested that British Embassies should be brought up-to-date by the appointment of additional staffs of specialists on commercial matters. He stated that Britain had a lot to learn from the U.S.A. in this connection.

LONG SERVICE with the group companies of John Thompson Engineering Company, Limited, Wolverhampton, was recognised recently when Colonel S. John Thompson, joint managing director, and Mr. H. B. Thompson, a director, presented certificates and gifts to 370 employees of 50 years' service downwards. Since the inception of the scheme in 1924 nearly 2,000 medals and certificates have been given to employees.

IT IS PROBABLE that conferences arranged by the division for the social and international relations of science, established by the British Association to deal with the impacts of science on society, will soon be held in provincial centres. Dr. O. J. R. Howarth, secretary of the Association, would be pleased to hear from any local organisation which would welcome a conference, on some appropriate scientific topic, in its own locality.

ASSOCIATION OF ENGINEERING DISTRIBUTORS, LIMITED, has been registered as a company limited by guarantee without share capital. The council is comprised of Mr. C. Summerfield, director of Geo. H. Alexander Manufacturing, Limited, Birmingham; Mr. W. G. Hatch, director, Geo. Hatch, Limited, 3, Queenhithe, London, E.C.4; and directors or representatives of Thos. P. Healand, Limited, James Lister & Sons, Listers Tools, Limited, Roberts, Black & Company, Limited, and Woodberry, Chillcott & Company.

ADDRESSING AN Industrial Welfare Conference at Oxford Mr. Arthur Greenwood, M.P., said that the problem of the transition from war industry to peace industry would dwarf into insignificance the complex questions arising from our efforts to put a peacetime industry on a war basis. The enormous development of plastics, with its almost illimitable usage, might well disturb the balance and importance of many well-established industries. Opportunities for overseas markets would depend on the rate at which the change-over took place.

IT WAS ANNOUNCED at the end of a private session of the conference of the Transport and General Workers' Union in Edinburgh last week that the conference ratified an agreement entered into by the executive with the Amalgamated Engineering Union, the National Union of General and Municipal Workers, and the Iron and Steel Trades Confederation, pledging the four unions to assist each other in getting 100 per cent. organisation of women employed in the engineering industries and regulating the relations of the four unions in this connection.

THE MINISTRY OF LABOUR AND NATIONAL SERVICE, in conjunction with the Board of Education and the Scottish Education Department, is organising courses of lectures on production planning at various technical colleges throughout the country. The courses will normally be of 20 hours' duration and will usually be given in evening meetings of two hours each. No fees will be charged for the courses, but no allowances or expenses will be paid by the Ministry. The courses are intended for men and women engaged on planning work in firms or with experience of such work and others with comparable experience who are capable of benefiting from the instruction given. Employers are particularly invited to put forward suitably qualified men and women from among their employees. Names and addresses of persons put forward by their employers or applying for the course on their own account should be sent to the local Employment Exchange with a reference to the scheme and with full details of technical experience and present employment. An examination will be held at the conclusion of each course.

RESTORATION OF INDUSTRY

A special report on the restoration of industry after the war was presented recently to the directors of Glasgow Chamber of Commerce by a committee appointed to study the many aspects of the subject.

The committee expressed complete disagreement with any policy of national control, and stated that to scrap or alter substantially the system of private enterprise in industry and supplant it by an untried and impersonal State control was in their opinion an unjustifiable gamble. It was generally recognised, the committee pointed out, that industry had co-operated wholeheartedly with the Government in the common effort to win the war. That co-operation had been on the understanding that the Government would do its utmost to re-establish concentrated industries as quickly as possible after the close of hostilities, or earlier should economic conditions make that possible.

Most if not all firms understood that they would be allowed and assisted to start up in their own industry in preference to new entrants. In other words, raw materials, factories, and the release of key personnel must first be made available to firms which had been concentrated. Many firms whose premises had been utilised for war purposes, either for production outside their normal activity or for important national storage had been unable to ascertain when their factories would be restored to them. It would appear that certain Government departments had reserved the right to use premises for as long as six years after the close of the period of emergency. As such cases were not uncommon, it was urged by the committee that Government departments should be pressed to give a specific undertaking in order that industrialists might be able to plan their post-war programme.

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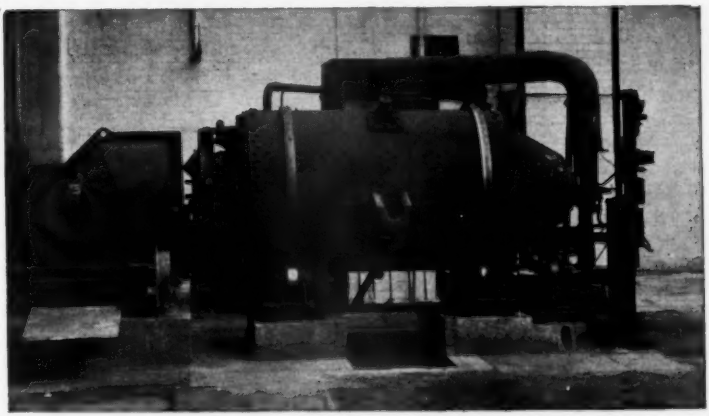

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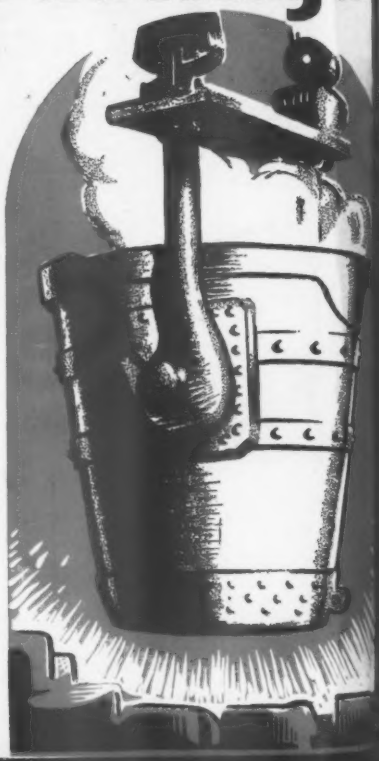

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